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New Horizons: Some Thoughts on New Ship Configurations (The Helicopter-Destroyer Concept)

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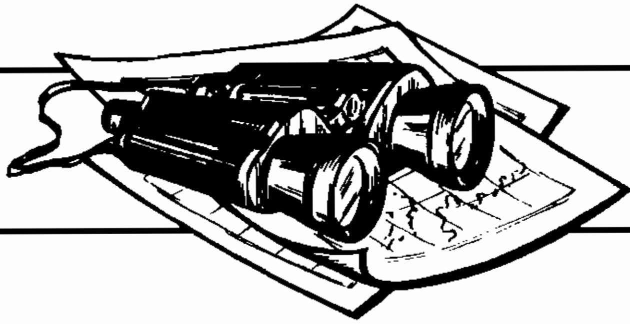

NEW HORIZONS

SOME THOUGHTS ON NEW SHIP CONFIGURATIONS

(The Helicopter—Destroyer Concept)

A lecture presented at the Naval War College

by

Rear Admiral Thomas D. Davies, U.S. Navy

on 5 February 1969

The purpose of this discussion is to outline a conceptual ship which exploits the helicopter as the basis of its weapon system and to indicate the merit of such a concept by some rough comparative measure with today's destroyer types. This concept is presented as an example of possible unconventional ideas which might impact on our Navy's ships to provide some more "revolutionary" changes. A thoughtful consideration of today's rising cost of naval ships convinces one that some new ideas may be needed. Rough comparisons of our ship's characteristics with those of such types as the USCG high-endurance cutter (table I) and recent Soviet fleet additions seem to raise some question as to whether the products of our current procedures for configuring and designing ships are all that they might be. Somehow our system seems to be too inflexible to generate or accommodate unorthodox ideas or nonconventional concepts. Hopefully, this discussion will generate interest and discussion to the point where an unorthodox concept will be given its day in court.

As a background for the comparison of an alternative ship configuration, I believe that some of the concepts of system analysis will be useful. These seem to provide a rational evaluation method for comparison of the proposed new concept ship with existing types. I will therefore digress with a short excursion into that somewhat controversial art.

I have often defined the system analyst as a man who "compares apples and oranges." Contrary to some opinion, such a comparison can be usefully made and provides the basis of the "trade-off" approach. Table II depicts a set of "indifference curves" used by the economist to show that

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TABLE I--COMPARISON OF MODERN NAVY DE WITH *HAMILTON*

	NOTIONAL DE	USCG HIGH ENDURANCE CUTTER[b]
Displacement	4,000[a]	3,050
Range--20 knots (approx.)	4,600	12,000
Shaft HP	35,000*	36,000
Maximum speed	27*	30
Crew accom (incl. off)	247*	187
Weapons	2 - 5 inch gun*	1 - 5 inch gun
	-	2 - 81mm mortars
	-	2 - 50cal M.G.
	ASROC*	HEDGEHOG
	Torp tubes*	Torp tubes
	Scanning sonar	Scanning sonar
	2 radars*	2 radars
	-	MF/DF, HF/DF
	ECM*	ECM
	DASH facilities*	Full helo fac's +1 helo (SIKORSKY)

[a]Raymond V.B. Blackman, ed., *Jane's Fighting Ships 1965-1966* (New York: McGraw-Hill, 1965), p. 358.

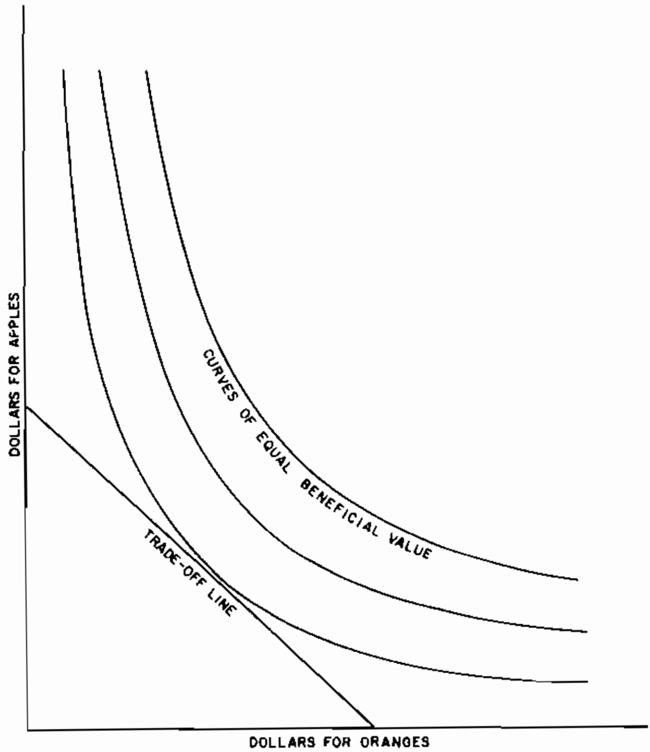
[b]U.S. Coast Guard unclassified pamphlet 1967-0-258-937, USCGC *Hamilton* (WHEC 715) (Washington: U.S. Govt. Print. Off., 1967), p. 8.

there are various combinations of apples and oranges (which plot along one of the curves) which provide the same total benefit--and consequently it is a matter of "indifference" to the user as to where on that curve his particular combination falls. Thus, from the standpoint of some undefined beneficial value to the user, each curve represents a set of combinations of equal value.

Actually, the curvature of the indifference curves also implies that there is a "saturation" effect in apples, oranges--or simply in numbers of weapons. That is, as an individual gets an increasingly greater number of oranges, he values them less and less. Thus, he will trade many oranges for only a few apples when he has an orange surfeit. In military terms the curvature implies that the military capability of the first increment of a weapon is of greater value than later increments, a concept which seems to be realistic

Given a fixed sum of money to invest, the straight line represents various combinations of apples and oranges which can be purchased. Thus, this line is a trade-off line. Moving along it, you are trading off apples for oranges (or vice versa), holding investment fixed. The point of this idea is that there is an optimum point where the investment will buy the most beneficial value (represented by the point of tangency with one of the family of indifference curves). To the investor this point tells him the relative numbers of apples and oranges to by with his fixed investment dollars in order to maximize his beneficial value. Note that the existence of this point depends on the assumption mentioned above which causes the "curvature" of the lines. With straight line

Table II



indifference curves there would be no optimum.

This discussion, of course, overlooks the real-world difficulties of placing actual values on the axes of the graph plus a host of other problems that could be raised by the practical man. Yet it does describe an approach that is useful --the concept of trade-off. The trade-off procedure clearly calls for *substitution* of one for another. As capability or beneficial values is added, some is also lost or removed--the net of these being an increase until the optimum point is reached. I reiterate this point because it is sometimes overlooked, and the trade-off becomes an add-on instead. Then, while the ship's costs necessarily include those of the added capability, they do not benefit from the reduction of the items which should be eliminated and yet whose contribution to capability is masked. Under these circumstances, our trade-off becomes an add-on, and ship costs rise without any compensating increase in capability.

In order to apply the trade-off concept to ship configuration (or any weapon system), we need to face the problem of quantification of the military capability which is the beneficial value in the real world. Of course, real finite quantification is never possible; we do not even have units in which to express it. Nonetheless, we can sometimes provide partial quantification which allows us to rank alternative configurations and provides a basis for choice or optimization. One example is the development of a search rate under conditions in which the probability of detection during the search is unknown but can be eliminated from consideration simply by providing that it is the same for alternative choices. I will develop several of these examples after we describe the ship; I believe that they will provide a feel for the selection of an optimum.

There is one final point as to the utility of system analysis in this type of exploration. It is the very apples and oranges aspect of the method which is essential to the evaluation of design which represents revolutionary departures rather than evolutionary development. If we are merely going farther with existing designs, no trade-offs need be studied at the individual ship level--there is no mystery about two guns ranking higher than one gun. The utility of system analysis comes when we are exploring the possibilities of substituting a component of an entirely different nature but which seems to give a similar capability in terms of ability to carry out the mission. If we can successfully quantify or rank such trade-offs, then we indeed have a way of evaluating unorthodox configuration.

We can approach the helicopter destroyer in just such a trade-off framework. Let us examine, for example, the trade-off of 5 inch guns and helicopters. We will use the 10-year-system costs since these encompass the effect of both investment and operating costs. Studies have indicated that the approximate 10-year cost of a 5 inch gun (including installation and operation) on a destroyer is about $10 million. The approximate 10-year costs of an installed helicopter of about the *Sky Knight* size, equipped only to carry a set of missiles calculated to attack the same enemy that the 5 inch gun is oriented toward, is about $3.3 million. (These costs are representative if there are a number of, say six to eight, helicopters sharing the same shipboard facilities). Thus we may say that the elimination of two 5 inch guns from our notional destroyer might allow a substitution of about six helicopters equipped to provide the same type of capability--all within our original cost envelope.

Table III is a table of comparative firepower resulting from this trade-off. While it is only approximate and certainly does not cover all possible scenarios, it does address the interesting cases of a duel with a missile-launching surface ship and that of firing at some shore target of specific nature and which can be considered to be killed in some relatively short period of time. The feel one gets from this comparison is that the DH (Helicopter Destroyer), in which two 5 inch guns are *replaced* by six to eight properly equipped helos, should rank well above the conventional DD.

There are other trade-offs that can be made which seem to add to the higher ranking of the DH. If we add radar/ECM equipment to the helicopters, again at the expense of removing this equipment from the ship, we can show an interesting result in some search rates that can be developed. Table IV tabulates some rough values. For submarine detections I have considered passive acoustic only for initial detections, but I recognize that active localization equipment must also be considered. Thus the helo MAD and active sonar/sonobuoy capability trade off against the DD sonar used actively. In spite of the complexity of making a trade-off in this area, the search rates of table IV do certainly call for a substantially higher rank for the DH than the DD.

In another area we might trade off an air-to-air-missile-carrying helicopter against a shipborne surface-to-air missile system. Only the roughest of costs are available here, but they indicate substantially greater ratios than the six to eight helos for trade-off against each SAM system. If we assume a probability constant (P_k) of .5 for our notional air-to-air missiles and an incoming raid of four antiship missiles, then a single helo airborne out of, say, eight on board (typical of a no-warning condition)

TABLE III--FIRE POWER

	DD	DH
Range at which DD can attack enemy surface ship	8/	60/
Range (approx.) of antisurface-ship missile	20	20
Pounds of warhead/min. delivered on surface targets (for short periods)		
At 5 miles distance	320	400
10 miles distance	320	400
20 miles distance	0	200
50 miles distance	0	66

TABLE IV--APPROXIMATE SEARCH RATES (IN SQUARE MILES PER HOUR)

	DE/DD	DH
Visual	200	1,200
Passive Acoustic	100	1,000
ECM	1,200	20,000
Radar	600	10,000

TABLE V--AAW FIREPOWER

Effective Kills Per Raid of 4 Antiship Missiles	DD	DDG	DH (6 Missions Per Helo)
With Warning	Very Small	4	4 (P_K= .5, 2 Helos)
No Warning	0	3	3 (P_K= .5, 1 Helo)

could account for three of the threat. Two helos airborne could counter raids of four to six missiles or aircraft. It is difficult to develop this comparison further on an unclassified basis, but I believe that it can be shown in table V that here again the DH ranks above the DDG.

Of course, there are some obvious advantages to having such items as a radar or ECM at 3,000 to 5,000 feet altitude with a corresponding electronics horizon or a passive underwater listening device (sonobuoy) which can be placed 50 to 75 miles (or more) away from the ship or, for that matter, two pairs of eyeballs which can be sent 100 miles away to report on some activity there. Also worthy of mention might be the COD capability providing material support to the ship when several hundred miles at sea. While it may be argued that one set of helicopters cannot do all of these things at once, there certainly can be substantial doubling-in-brass by the helos, as all of these capabilities are never demanded simultaneously. The composite helo unquestionably trades off even more favorably against the sum of the costs of guns, missiles, radars, sonars, and ECM equipment.

I think I should point out once again that the costs used in this article are of a very rough sort--intended to suggest how trade-offs might come out rather than show a finished result. However, it is noteworthy that costs are necessarily approximate in the best of analytical studies of things that haven't been done. Consequently, where results indicate only some small improvement in capability, they are really insufficient basis for a decision. The interesting and useful cases are those where the results show large improvements which would not be wiped out by cost fluctuations one might expect in the real world.

I believe that the helicopter destroyer is such a case. The sample comparative capabilities I have given certainly suggest large increases which could not be reversed by reasonably small cost changes. Further, these are computed for specialized helicopters in each case, without applying the benefits which would seem to obtain from the composite helicopters where many of the fixed changes support several types of capability--for example, AAW and ASW capability. The big increment of capability is the addition of the air vehicle; multiple weapon systems added to this vehicle require smaller increments of cost.

It will be argued that the helicopter is vulnerable to counterfire, that it cannot operate in some degrees of foul weather, or that it cannot accomplish some of the things we now do with our destroyers. In each of these (and other) arguments, there is obviously a degree of merit. There is, however, a tendency to argue in terms of the single case of the helicopter facing some constructive hostile stituation. I would point out that the consideration must be in terms of alternatives; that is, the destroyer must be placed in the same scenario with the helicopter destroyer and their relative capabilities ranked.

There will always be inadequacies in such arguments since scenarios are necessarily broad-brush, and many times their true nature does not meet the eye--even of experienced operational officer. In such items as shore bombardment, for example, we tend to use rounds-fired-per-month as a measure of effectiveness; whereas, if we were able to examine military targets on the beach, we might find that helicopter weapons of an entirely different nature would be equally or more effective (napalm for example). Clearly, all arguments cannot be resolved by discussion or analysis; these serve only as suggestive guides--the real proof is in the "doing." If the analyses, done with reasonable accuracy and completeness, do support the view that in important areas there are large gains in capability, then our next step must be to build such a ship (or assemble it out of existing components) and submit it to the trial of operation for a period long enough to give us real insight into its beneficial value.

Turning now to the helicopter destroyer itself, I hasten to point out that I cannot produce an optimized ship but only a suggestion of what it might look like. There are certain practical factors which need to be considered in any ship. I believe the first of these is

BIOGRAPHIC SUMMARY

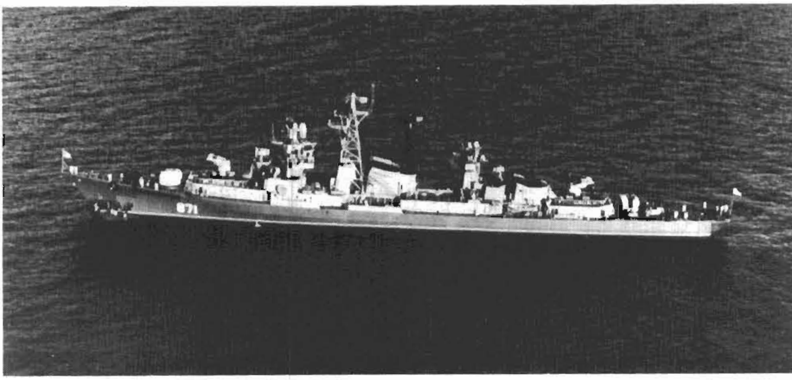
Rear Adm. Thomas D. Davies, U.S. Navy, is a graduate of the U.S. Naval Academy (Class of 1937) and of the National War College. He has had a wide and varied experience in the conceptual design and operation of fleet aircraft. He was pilot of the P2V *Neptune*--The Truculent Turtle--on its world's distance record flight, he piloted the first P2V from the deck of a CVA, and held the transcontinental East to West speed record. In his duties dealing with development, he has served in the Office of Naval Research; with the Bureau of Aeronautics as Director, Contract Division; and subsequently assumed the position of Director of the Department of the Navy Program Appraisal Office, Navy Department. In March 1969, Rear Admiral Davies was attached as Commander Carrier Division 20 and assigned as Deputy Chief of Naval Material and Plans, and Chief, Naval Development, Washington, D.C.

sea-keeping ability, and this would appear to call out a ship of 5,000 to 6,000 tons displacement with high freeboard and some effective form of stabilization (probably the so-called flume system since that functions independently of ship's speed). With the new ability of the DH helicopters to "reach out" for a hundred miles or more, top speed would appear to be of less importance and could be traded off for sea-keeping ability by departing from the narrow-waisted hull of the classical destroyer.

The ship, in this concept, functions essentially as a logistic base for the air vehicles and its weapon system. Beyond hangar and flight-deck space for the operation of its inventory of helos (six to eight), the hull should cater to the carrying of quantities of fuel (both ship and aircraft), weapons, and the hotel items for its personnel. Endurance is difficult to specify for such a loosely defined ship; it might be such as to provide an at-sea unrefueled operating period of about 14 days at a speed suitable for escorting which might mean a tactically usable endurance of about 5,000 miles at 15 knots plus a reserve of about 2,000 miles at 20 knots. This would be matched by helo fuel for the same period which would provide about 1,000 hours of helo fuel plus a reserve.

In conclusion, I would note again that this is far from a finished ship design, but it is a concept that shows promise and needs to be prosecuted. The method I have described is an approach to ship configuration which I think may well be productive in accommodating and generating unorthodox and hopefully valuable ideas. I believe it can be applied usefully to other ships, and it should be. Finally, I note the importance of the use of the trade-off and the avoidance of the add-on if we are to really generate units of greater effectiveness for the Navy without finding ourselves with a dwindling inventory as a result of ballooning costs.

USCGC *Chase* (*Hamilton* class) is an example of the impact of a new propulsion system (CODAG) on ship capabilities. She is noteworthy for having very long range with weapons and equipment, comparable to a USN destroyer escort type, within a relatively modest displacement (about 3,000 tons). Outstanding habitability is another feature. (USCG photo).

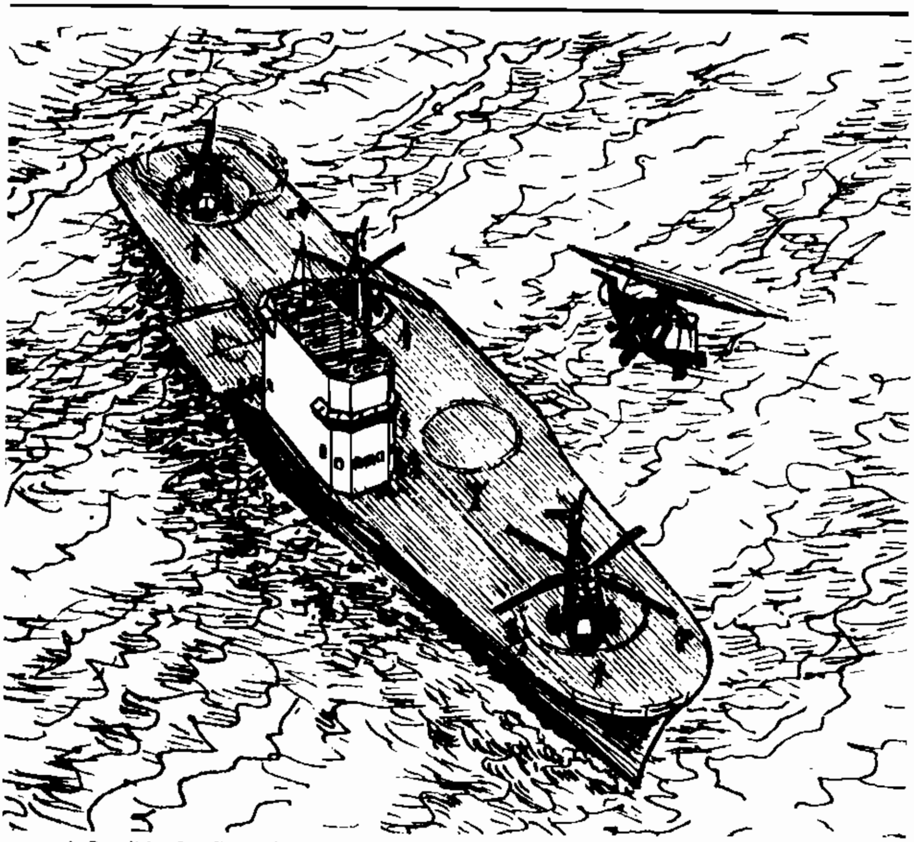


U.S.S.R. Guided Missile Destroyer of the *Kashin* class displays an impressive array of equipment and weapons on a hull of about 5,000 tons displacement. The "knuckle" visible in the side suggests the designer's appreciation of the importance of "volume" in the ship. Her "payload," very high speed, and good endurance reflect some of the benefits of her gas turbine power plant.

Source: Raymond V.P. Blackman, ed., *Jane's Fighting Ships 1965-1966* (New York: McGraw-Hill, 1965).

U.S.S.R. patrol craft shows an unusual gas turbine power plant located in an afterdeck house with jets exhausting into the wake, producing a "rooster tail" at high speed.

Source: Raymond V.P. Blackman, ed., *Jane's Fighting Ships 1965-1966* (New York: McGraw-Hill, 1965).



A Possible Configuration for the Helicopter Destroyer. With flume stabilization, effective at low speeds. The flat top permits best orientation of hull to wind and sea for flight operations.

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THE BAROMETER

The letter which follows was received by the President of the Naval War College and is published with his permission.

I have read with great interest your Editorials "Challenge" in Volume XXI, Numbers 3 and 4 of the *Naval War College Review* to which I fully agree. I also understand the particular reference to the Mediterranean Sea in view of the quotation of Mahan.

But since you specifically mention the Indian Ocean, I would like to point out that there are two further examples to prove the Soviet change of mentality from a continental to a seapower, which are of the greatest importance to Europe and for the understanding of the European situation: I mean the change of the character of the Soviet Northern and Baltic Fleets. As you already pointed out in general terms in your first article, the Soviet Northern Fleet is expanding into the Atlantic with her submarines and missile-launching forces; on the other hand the modern Baltic Fleet represents for this theatre a powerful naval force with an important amphibious capacity and a corresponding amphibious assault element. Both were nonexistent some years ago, and they are now the best proof for the change from a defensive to an offensive maritime strategy in the confines of the Baltic. Furthermore, they can be supported by shore-based aircraft and missile-launching batteries as well as by Polish and East-German naval forces of a similar character.

These facts are of vital importance both to the Royal Danish and the Federal German Navies living in the immediate vicinity of the Soviet naval threat posed in the Baltic and its approaches.

It might be useful to give these facts a wider publicity, also in Germany for a better understanding of our situation and the responsibilities as laid down by NATO.

I am fully aware of your objective to give a picture of the worldwide consequences brought about by the change in Soviet maritime strategy.

WOLF-DIETRICH BABBEL
Captain (FGN)

Following is an excerpt of a letter from Professor Lyman B. Kirkpatrick of Brown University to the President of the Naval War College.

. . . . . .

I would like to take this opportunity to comment on the presence in my graduate seminar at Brown University on American Security Policy of students from the Naval War College. This seminar was presented during the first semester of this academic year and it was my pleasure to have among the students taking the course, Messrs. Fugett, Hendricks, McCleave and Phillips from the War College. Also in the course were three other students either on active duty or with a military backgound and seven Brown graduate and undergraduate students. This combination proved to be most stimulating and beneficial. From every one of the Brown graduate and undergraduate students I received many comments as to how much they gained from the association with the officers from the War College. To many it gave a com-